Attachment A
Research Proposal Template
Roads & Highways Monitoring Committee
Subgroup of the Stormwater Working Group

1. RESEARCH PROPOSAL TITLE

Stormwater Treatment Performance of Modified Vegetated Filter Strips

2. RESEARCH PROBLEM DESCRIPTION

Background

Stormwater runoff has been identified as the single most significant source of pollution in Puget Sound and a major environmental stressor in other areas of Washington State. Transportation departments across the state are under increasing pressure to manage stormwater discharges from roads and highways. Finding effective, low cost best management practices (BMPs) that can be broadly applied to treat stormwater runoff is a priority.

Vegetated filter strips (VFSs) are preferred highway BMPs that provide a solution that may help address this need. VFSs are sloping land areas with planted vegetation and amended soils that are used to treat stormwater sheet flow from roads and highways. VFSs function by slowing runoff velocities, filtering sediment and other pollutants, and providing some biologic uptake and infiltration into underlying soils (WSDOT 2011).

Basic VFSs and *compost-amended VFSs* (CAVFS) are preferred filter strip designs. A basic VFS is a compacted roadside embankment that is hydroseeded with an established grass seed mix. A CAVFS is a variation of the basic VFS that adds soil amendments to enhance infiltration characteristics, increase surface roughness, and improve plant growth and cover (WSDOT 2011).

What is the problem?

While CAVFS provide performance improvements over the basic VFS design, construction is more expensive and installation is not feasible in many situations. This is particularly true in urbanized environments. A typical CAVFS installation requires heavy equipment to incorporate compost into the top 12 inches of soil. In areas where access and space are limited or slopes are too steep, CAVFS are not an option. An alternative to CAVFS that provides similar levels of water quality treatment is needed.

Why do we need to solve this problem?

Stormwater management has become a major expense and growing concern for transportation departments across the state. As regulatory requirements become more stringent, new and innovative BMPs that achieve high levels of treatment performance at low cost are needed to mitigate the effects of stormwater runoff from roads and highways.

Shortcomings of existing methods?

When compared to basic VFSs, CAVFSs provide greater surface roughness, higher retention and infiltration capacity, enhanced removal of soluble cationic pollutants, improved vegetative health, and a reduction in invasive weeds (WSDOT 2011). While basic VFSs are low cost and relatively easy to install, CAVFSs construction materials are more expensive and the BMP is more difficult to install. CAVFSs installations require good access and adequate space for heavy equipment to till compost into the top layer of the soil. In more highly urbanized environments, CAVFSs installations are usually not possible.

3. RESEARCH OBJECTIVE

Objective: To evaluate the treatment performance of a modified VFS.

This proposal describes a structural BMP effectiveness study.

X Effectiveness *____Source Identification* *____Status & Trends*

4. LITERATURE SEARCH AND RESEARCH IN PROGRESS SUMMARY

Vegetated filter strips (VFSs) are among the simplest, most cost-effective means of controlling the effects of stormwater runoff (Deletic and Fletcher 2006, WSDOT 2011). Studies suggest VFSs can be effective in improving water quality by reducing pollutant concentrations of total suspended solids, heavy metals, polycyclic aromatic hydrocarbons (PAHs), and phosphorus (Abu-Zreig et al. 2003, Kaighn and Yu 1996, Line and Hunt 2009). Several studies also support the mass retention capabilities of VFSs for heavy metals by observing significant percent reductions in zinc and copper (Dorman et al. 1996, Ebihara et al. 2009, Kaighn and Yu 1996).

Adding soil amendments to VFSs can improve functionality (Goodwin et al. 2011, Persyn et al. 2002). In particular, compost amendments can enhance soil quality and texture, improve infiltration, and enhance treatment performance of VFSs. The high cation exchange capacity (CEC) of compost chemically traps dissolved metals and binds them to compost material. Oils, grease, and floatables are also removed from stormwater as it is filtered through the compost. Although flood attenuation capabilities of VFSs and compost-amended VFSs (CAVFSs) are largely unknown, qualitative observations indicate that on outwash soils CAVFSs can significantly reduce off-site flows (WSDOT 2011). Other studies support these findings and suggest that VFSs treated with compost prior to vegetation growth have significantly lower erosion and runoff rates compared to untreated or unvegetated areas (Persyn et al. 2002).

As an alternative to CAVFS installation, the Washington State Department of Transportation (WSDOT) is currently evaluating a modified VFS where compost is applied as a 3-inch blanket to the surface of the soil. In comparison to CAVFS, the *compost-blanket VFS* does not require heavy equipment to till compost into the top 12 inches of the soil, making the cost of installation less expensive. For linear freeway projects in particular, the cost of CAVFS installations may be too high, whereas compost-blanket VFSs are more affordable.

The potential advantages of modified, compost-blanket VFSs include reduced costs for construction because compost-blanket applications require minimal ground disturbance, fewer traffic impacts, and less traffic control. In addition, compost blankets may be applied on steeper slopes, over broader areas, and earlier in the construction process as erosion control. Finally, compost-blanket VFSs can be applied in confined spaces, including urban areas, where CAVFS installations are usually not possible.

Further investigation is needed to evaluate the properties of the compost-blanket VFS. Monitoring is necessary to provide designers with information they need to model water losses. Compost-blanket VFSs need to be tested to ensure treatment potential and capabilities are similar to CAVFS.

Literature Cited

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WSDOT. 2011. Highway Runoff Manual. Washington State Department of Transportation, Environmental and Engineering Programs Design Office, Olympia, WA. Publication M 31-16.03.

5. Geographic Scope and Urgency of Research

How broadly will the results of this research apply?

X Nationally X Pacific Northwest ____WA Only X Eastern WA X Western WA X Puget Sound Basin

How quickly will you need the results of this research?

X ASAP ____Within 6 months ____Within 1 year ____Within 2 years ____Within 5 years ____Ongoing

This research study has statewide applicability for roads and highways. Findings from this study could also be used to inform projects in the Pacific Northwest and other regions of the country.

Results from this research will be used as soon as they are available to inform BMP designers in transportation departments statewide. This research will also be used to inform the *Highway Runoff Manual* (WSDOT 2011).

6. Conceptual Research Approach

This proposal supports continuation of a WSDOT BMP effectiveness study currently conducted at two locations along Interstate 5 (I-5) north of Everett. The challenges involved in developing these VFS study sites have already been addressed. Monitoring is technically feasible, though traffic volumes during peak travel times at one of the study sites sometimes restricts activities along the road shoulder for safety reasons.

This study satisfies monitoring requirements in the agency's current NPDES municipal stormwater permit as well as research interests of the department. This study also addresses recommendations in a white paper developed for the Stormwater Work Group (SWG) as part of their stormwater management effectiveness literature review. This SWG white paper recommends the following (Milesi 2013):

- Conduct studies of filter strips in western Washington where light to moderate rainfall and flow intensities may show increased effectiveness of narrower filter strips.
- Perform field studies in western Washington on filter strips of varying widths, slopes, and vegetation to determine if there is an optimal combination.
- Construct and perform field studies on a filter strip that is narrower than eight feet to determine if performance meets the Washington State Department of Ecology's guidelines for basic treatment.

When the agency's current NPDES permit expires in March 2014, WSDOT will have one year of monitoring data. More monitoring will be required to meet statistical goals in the Technology Assessment Protocol – Ecology (TAPE) (Ecology 2011). Support from WSDOT management, the WSDOT Stormwater Research Office, and Washington State Department of Ecology will be needed to continue this study.

VFS Study Site Descriptions

This study compares treatment performance of an existing VFS to a modified VFS (compost-blanket VFS) at two locations along Interstate 5 (I-5). A CAVFS is installed at one of these locations for additional comparison. Stormwater interceptors (HDPE half-pipe collectors) are positioned along each VFS at the edge of pavement, and two meters, and four meters downslope. Treatment performance from the edge of pavement (influent samples) and the two and four meter collection

points (effluent samples) will be evaluated.

The two meter, effluent sample collection points are included as part of the study's sample design because highways in highly urbanized areas may have limited space for stormwater treatment along the road shoulder. Much of the flow reduction and water quality treatment are expected to occur close to the edge of pavement.

The four meter, effluent collection points are included to evaluate the additional treatment performance of the BMPs on the road shoulder embankment.

7. ESTIMATED COST AND TIMING (Optional)

A typical monitoring budget includes the following:

Planning (≈ 20% of budget)

- Background research (e.g., previous, similar studies)
- Develop site selection strategy
- Field reconnaissance for final site selection
- Develop project scope and sample design
- Develop the monitoring QAPP

Implementation (≈ 80% of budget)

- Equipment and supplies (purchase, installation, maintenance, and replacement)
- Database development and implementation
- Training
- Logistics (e.g., pre-storm prep and post-storm sample transfer)
- Sample collection (e.g., staff time, travel expenses, etc.)
- Laboratory analysis
- Verification and validation (data QA/QC)
- Data management
- Data analysis and report writing

Since this proposal describes an ongoing WSDOT study, the agency has already paid for the planning and many of the study implementation costs. The current study is expected to continue until statistical goals as defined in the *Technology Assessment Protocol – Ecology (TAPE)* (Ecology 2011) are met.[1]

A next step might be to expand the current study to a limited number of additional sites to see if results can be duplicated elsewhere and the BMP can be more broadly applied. Based on previous WSDOT experience, the following provides an estimate of equipment purchase, site construction, and laboratory analytical costs for development of one additional compost-blanket/basic VFS study site:

- Equipment purchase ≈ $43,000.
- Construction ≈ $26,000.
- Annual analytical costs ≈ $48,000.[1]

[1] Laboratory costs vary depending on the list parameters identified for the study, fees charged by individual laboratories, and sampling success. The estimate assumes 12 storms are sampled each year and includes laboratory data verification and validation costs.

8. CONTACT INFORMATION

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